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A field study of the social behavior of Goeldi's monkeys (*Callimico goeldii*) in North Bolivia

II. Grouping pattern and intragroup relationship

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ABSTRACT. The intragroup relationship of an artificially baited group of *Callimico* was investigated by observing the grouping pattern, grooming relations, agonistic interactions, and food-dominance among individuals. For the first two months, the group was likely to segregate into two subgroups. Each of them was made up of an adult female and her offspring. The group became cohesive after two infants were newly born. In November, a juvenile female left the group. As the infants got independence, the cohesiveness of the group decreased again. They came to interact with other juveniles frequently. Therefore a kind of peer grouping occurred, being separated from the subgroup of adult individuals. These changes of the social relations among group members are discussed in terms of the reproduction, infant development, and change of the age-sex ratio of the group.

INTRODUCTION

Primate societies have been customally divided into three types, monogamous group and polygynous group which is divided into single-male group and multi-male group (CROOK & GARTLAN 1966, ITANI 1973). On the other hand, the variability of social structure have also been studied since the research of JAY (1965) on langurs. Among others, the effects of reproductive cycle on the group organization have been intensively studied by ROWELL (1972) and DUNBER (1979). Compared with that in non-breeding season, the group is supposed to be more cohesive in the birth season. The fact has been explained in relation with effective reproductive strategy and infant development.

On the contrary to the perspective generally accepted, MASATAKA (1981) indicates that *Callimico*'s social structure does not belong to monogamous type. More than a female can be pregnant in each birth season in the group. Mean size of a *Callimico*'s group, however, is supposed to be exceptionally less than that of other polygynous groups of primates previously investigated. The aim of this paper is to study the intragroup relations and their changes induced by the breeding and infant development in *Callimico*.

RESULTS

Grouping pattern

Since the success of the feeding of a group of *Callimico* at the end of July, its members came to visit the feeding site every day. All of them, however, were not always observed together. Frequently, some individuals were found to eat bananas while others were absent. Some group members tended to associate with each other more often than with others, as pointed out by Figure 1, showing grouping pattern, scored each time when individuals came to the feeding site together within 5 minutes.

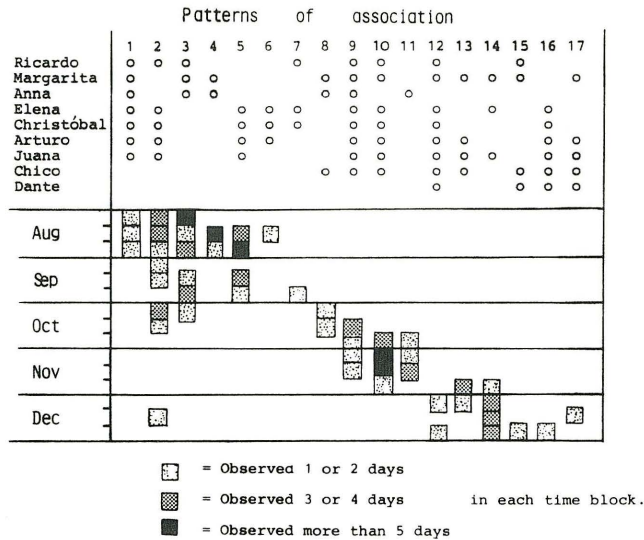


Fig. 1. Grouping patterns observed in the feeding site.

Three time blocks of each month include first, second ten days, and the rest of the month, respectively.

For the first two months, mean size of grouping was 3.3 individuals. Ricardo and two adult females occupied approximately two-thirds of the total individuals observed. Concerning its composition, two types of patterns were distinct. Margarita was seen with Anna most frequently, while Elena with Christóbal, Arturo, and Juana. Ricardo tended to be observed in both subgroups. This trend is indicated, too, by Figure 2, which shows the dendrogram of the association pattern of group members, made on the basis of percentages of each dyadic association out of total sampling. Two subgroups were likely to be separated each other except for Ricardo.

In this period, the group was awake from 06.30 h. and used to come to the feeding site within an hour. For the progression, they usually used the lower strata in the canopy, i.e. at the height of 1.5–2.0 m, compared with other sympatric tamarins. The sleeping sites of *Callimico* were found on 4 days. Once, the group was segregated into two sites which were separated more than 100 m each other. On another occasion, the group used a hole in the center of the Y-shaped tree for the sleeping site.

In October, distinct change occurred in the grouping pattern. The mean size increased

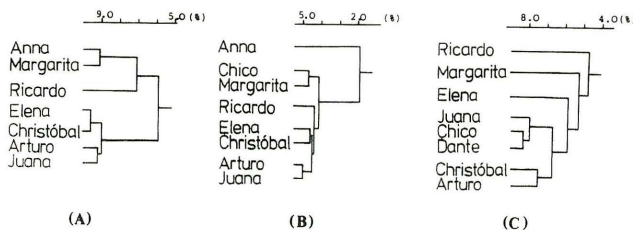


Fig. 2. The patterns of associations among group members.

(A) August and September (B) October and November (C) December

sharply. It attained 5.8 individuals. Every group member came to be seen together much more frequently than before. The group became very cohesive on the whole. On the contrary, Anna was observed to come to the feeding site alone at the end of October, though other group members were not seen to be alone throughout the investigation period. The dendrogram Fig. 2(B) indicates almost identical association among group members except for Anna, who was isolated from them.

Chico, released into the group in this period, was observed to be with Margarita most frequently, and never be with others. Before his release into the group, Chico had showed particular response to Margarita, when she visited the feeding site where he was exposed in the small cage. Specific infantile begging calls were emitted solely towards her, to which Margarita responded by attempts to approach, touch, and groom him. The same occurred between Dante and Elena, whereas any other individual never performed these behaviors to Chico or Dante in the cage.

In December, another change was induced again. Compared with in October and November, the group cohesiveness decreased. Although the mean size of grouping was identical with that in August and September (3.5 individuals), Juana, Chico, and Dante were often seen to be together, compared with adult individuals. Even when Margarita was observed, Chico and Arturo followed her on many occasions. Elena was frequently found to be with Juana and Dante.

Intragroup relations

When aggressivity was expressed by *Callimico*, arch posture and mouth-open face were often seen as described by EPPLE (1967). Except for these displays, approach-avoidance interaction also occurred in the following manner. An individual attempted to approach the feeding table, on which another was feeding, the latter resigned himself of eating and avoided, or transferred to the other place on the table. Then the former fed instead of the latter. In Table 1, linear approach-avoidance relationship is seen between group members except for the pair of Elena and Anna, though a few exceptional incidents occur. For the first two months, Elena withdrew in most cases where Anna appeared. The latter avoided the approach of Margarita. Ricardo tended to be avoided by every individual whereas Juana was by none. Although all 6 individuals used to feed without any agonistic interactions in a sympatric group of *S. fuscicolis*, *Callimico* was not as tolerant to co-feeding as tamarins.

Table 2 indicates co-feeding relations among group members, expressed as percentages of the total sampling, in three periods divided in the same manner as that in Figure 2. In August and September, its proportion was high between Margarita and Anna, and among Christó-

Table 1. Approach-avoidance relationship among group members.

Avoiding animals							
Approach- ing animals	Ricardo	Marga- rita	Anna	Elena	Chris- tóbal	Arturo	Juana
Ricardo	—	45	28	33	15	8	16
Margarita	—	—	16	29	9	16	14
Anna		2	—	67	21	24	7
Elena		1	13	—	12	11	9
Christóbal				2	—	17	30
Arturo				1	1	—	23
Juana				3	1	2	—

Table 2. Co-feeding ratio of each dyadic pair out of the total sampling.
(A) August and September (B) October and November (C) December

(A)							
	Ricardo	Margarita	Anna	Elena	Chistóbal	Arturo	
Ricardo	—						
Margarita	6.0	—					
Anna	4.9	8.2	—				
Elena	5.7	3.8	1.1	—			
Christóbal	2.4	2.1	4.9	7.0	—		
Arturo	3.0	1.9	2.1	5.2	5.9	—	
Juana	2.7	2.8	2.2	8.9	6.2	5.9	
N = 86							
(B)							
	Ricardo	Marga- rita	Anna	Elena	Chris- tóbal	Arturo	Chico
Ricardo	—						
Margarita	8.1	—					
Anna	1.3	0.9	—				
Elena	4.9	11.0	1.1	—			
Christóbal	3.2	6.0	0.6	7.9	—		
Arturo	4.7	6.4	1.7	7.1	5.4	—	
Juana	5.2	3.4	0.9	8.8	4.9	6.4	—
Chico	3.8	12.1	2.1	4.9	3.4	4.9	8.1
N = 56							
(C)							
	Ricardo	Marga- rita	Elena	Chris- tóbal	Arturo	Juana	Chico
Ricardo	—						
Margarita	4.3	—					
Elena	3.5	2.9	—				
Christóbal	0.5	2.4	2.1	—			
Arturo	0.8	1.3	0.8	6.9	—		
Juana	1.1	1.1	0.5	5.6	2.4	—	
Chico	1.1	6.9	3.7	4.8	3.7	7.5	—
Dante	1.3	3.2	6.7	4.3	3.5	6.7	8.8
N = 25							

bal, Elena, and Juana. Ricardo was tolerant to Margarita and Elena. The mean number of members in a co-feeding interaction was 2.4 in this period.

In October and November, however, the mean number increased sharply, and attained 4.0 individuals. Its rate of the total sampling increased between Margarita and Elena, whereas decreased to the identical extent between Margarita and Anna. Among other members, the proportion was likely to be more than that of before. Chico fed with Margarita most often. In December, it was noteworthy that Margarita and Elena came to feed rarely with others except for feeding with Chico or Dante. The same held true for Ricardo. On the other hand, cohesive co-feeding relations were found among Christóbal, Arturo, and Juana.

Grooming and aggressive interactions occurred between group members are shown in Figure 3. For the first 50 days, more than two-thirds of grooming interactions were observed among Ricardo, Margarita, and Anna. He received grooming more often than he did. On the whole, male animals performed grooming less frequently than did females. It constitutes approximately 30% of the total sampling.

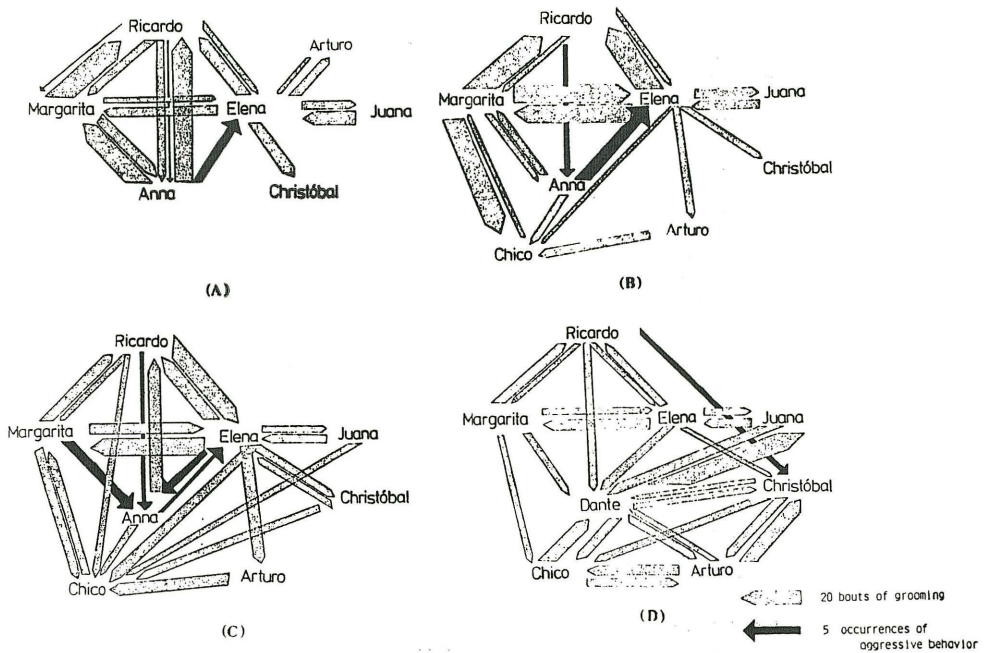


Fig. 3. The social relations among group members.

(A) August 1 to September 24 (B) September 25 to October 14 (C) October 15 to November 14 (D) November 15 to December 28

Mutual relations were seen between Margarita and Anna. As pointed out by Figure 4 which lists occurrences of triadic interactions concerning grooming and aggressive behavior, grooming interaction between Elena and Ricardo, or between Elena and Margarita was likely to elicit attack by Anna to Elena. When the latter was performing grooming, the former approached and chased her out, and then Anna groomed Ricardo or Margarita. When she received aggressive behavior from Ricardo, Anna tended to redirect it to Elena, while grooming did not occur between them. Arturo, Christóbal, and Juana were involved in grooming interaction only with Elena. Neither agonistic nor grooming interaction occurred among them.

By the delivery of Margarita, intragroup relations changed (Fig. 3 (B)). Margarita and Elena groomed each other much more frequently than before. Considering that this sociogram expresses interactions during 20 days, the mean frequency of grooming also increased between Ricardo and Margarita, or between Ricardo and Elena. Anna came not to groom Ricardo but receive aggressive behavior from him more often. The occurrences of grooming decreased between Margarita and Anna, while Margarita performed it to Chico who was released into the group.

After the birth of Elena's infant, Margarita was interested in and took care of it frequently. The identical tendency was also found between Elena and Margarita's infant. On the other hand, Anna who had tended to follow Margarita before, began to space out from her with the decrease in the frequency of grooming to Anna. Anna's aggressive tendency to Elena increased in its degree when sexual behavior was seen between Ricardo and Elena. They have been in intimate grooming relationship since their copulation, whereas Anna came to be in more agonistic relations with Elena. When Elena was attacked, however, Ricardo was observed to perform aggressive behavior to Anna as if he protected Elena from her. Even when

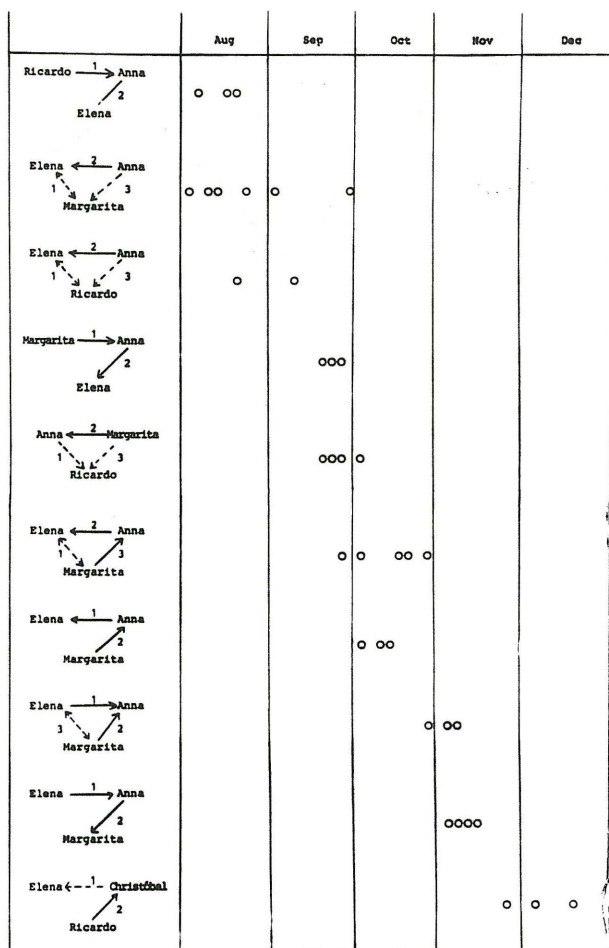


Fig. 4. The occurrences of triadic interactions.

A→B: aggressive action by A towards B

A→B: grooming by A towards B

The order in which these bouts of behavior began is indicated by the figures.

Ricardo or Margarita were participating in grooming interaction with Elena, Anna's attack to Elena did not interrupt that interaction. The frequency of Anna's approaching or following to Ricardo gradually decreased. The relations among Christóbal, Arturo, Juana, and Elena were almost identical with those of before.

Gradually Anna came to attack Elena less often since Ricardo's protective tendency to Elena was seen. Although Anna began to attempt to groom Ricardo and Margarita again, her attempts were kept to be rejected by them. They did not approach to groom Anna (Fig. 3(C)). When Elena and Margarita were in grooming relationship, Anna was observed to chase Elena out and attempt to approach Margarita. This, however, elicited Margarita to attack Anna. In addition to this, Anna's approach to Ricardo came to elicit Margarita's aggressive behavior. When she was attacked, Anna redirected aggressive behavior to Elena, who was supported by Margarita and received grooming from her. Sometimes Margarita chased out Anna again. Ricardo did not participate in the interaction even when he was present.

On October 18, Anna received much more attacks from Margarita and Elena than she had ever experienced before. Since this day, she tended to avoid Elena. Approach-avoidance relations between them also reversed in this period. Elena came to be the approacher, and Anna was the avoider. Elena was likely to initiate agonistic interactions toward Anna, who came to visit the feeding site alone. The occurrences of these interactions were kept to be seen till the disappearance of Anna.

Since October, Chico was groomed more frequently than before by Christóbal, Arturo, and Juana. Grooming occurred often among 6 non-adult individuals in December. Although Dante was newly introduced into the group, he also participated in grooming interaction as often as did others. The triadic interactions, which had been seen before, did not occur. Christóbal was attacked by Ricardo when he attempted to approach Elena. Margarita and Elena tended to keep proximity with non-adult individuals.

The new-born infants were also likely to be with other juveniles. In the group progression or foraging, non-adults were observed to be together, whereas adult individuals followed their own infants, though usually spaced out a little. Adults tended to observe the interactions performed by the infants, and sometimes attempted to keep contact with them. Non-adults, however, avoided in many cases. Adult individuals were less cohesive than non-adults.

DISCUSSION

In the first two months, two different subgroups were distinct, i.e. one consisted of Margarita and Anna, and the other of Elena, Cristóbal, Arturo, and Juana. These results are corresponding to the sociogram of intragroup relations in this period. Grooming interaction occurred mainly among Ricardo, Margarita, and Anna, while Christóbal, Arturo, and Juana were observed to groom solely with Elena. Food dominance relations could be observed evidently in *Callimico*, whereas food-sharing behavior was seen in common in sympatric tamarins. The former three individuals were more dominant than other members. Dominant-subordinate relationship consisted with age seniority of individuals except for the pair of Anna and Elena. Anna was more dominant than Anna who was older than Anna. Physical aggressive behavior occurred in this period was mainly performed by Anna to Elena. In triadic interactions shown in Figure 4, Anna was likely to interrupt grooming between Ricardo and Elena, or between Elena and Margarita. Anna probably attacked Elena in order to prevent her from having psychological alliance with Ricardo and Margarita. They tolerated the aggressive behavior by Anna to Elena. Grooming by Anna to Ricardo and Margarita might suggest that she was in more intimate relations with them than Elena was.

On the contrary, the reactor alliance defined by DE WAAL *et al.* (1976) was observed between Elena and Ricardo, or between Elena and Margarita in October. Then Elena became more dominant than Anna, and attacked her. The actor alliance among Elena, Ricardo, and Margarita came to be seen. The group became cohesive, and grooming occurrences increased between Margarita and Elena.

When new-born infants were 30–40 days in age, the occurrences of grooming decreased. The subgroup which was consisted of only peer individuals came to be found. The absence of Chico and Dante in the group since June may be difficult to neglect in order to consider these changes of social relations. That Dante was introduced into the group when new-born infants had just gotten their independence might contribute to the intimate relationship among non-adults. The disappearance of Anna is supposed to have some effects on the social interactions.

Considering the infant development and behavior of Chico and Dante to Margarita and Elena, the grouping pattern is supposed to have been influenced by the genealogical relations among group members. Two kinship clusters existed in the group. One was consisted of Margarita and Anna, the other was of Elena, Christóbal, Arturo, and Juana. These relations were seen in the grouping pattern more distinctively in August and September than in other periods. In October, the cohesiveness of the group increased. This change correlates with the infant development and care-taking behavior. New-born infants were paid attention by every group member. The cohesive grouping might function in order to protect the infants and their mothers handicapped in locomotion against predator animals. The fact that the group came to be less cohesive at the stage when the infants became independence from their mothers might support these considerations.

The disappearance of Anna is supposed to be relate with the reversal of the dominant-subordinate relationship between Anna and Elena. The alliance formation between Elena and Ricardo, and between Elena and Margarita had affected the change. Possibly, Anna is considered to have left the group spontaneously, though other possibilities cannot be excluded completely. The relationship between Anna and Margarita, which changed into more agonistic one than before, indicates preceding stage for Anna's leaving from the group. The fact that Anna has come to full sexual maturity in this period may have elicited Margarita's aggressive behaviors. Most of group members of *Callimico* are considered to leave their native group in the process of their life history.

When compared with other primate species, the group size of *Callimico* is rather small. The species-specific characteristics of *Callimico* that more than a fertile female can exist in a group may constitute *Callimico*'s distinctive features in its social structure from those of tamarins and marmosets. These results indicate long-term variation of group organization of *Callimico* induced by the breeding of females and infant development.

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